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BULLETIN
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Sphaerocarpos hians sp. nov., with a revision of the genus and
illustrations of the species

CAROLINE COVENTRY HAYNES

(WITH PLATES 25-32)

While studying a remarkable *Sphaerocarpos* from the state of Washington, under the direction of Dr. Marshall A. Howe, the writer became gradually acquainted with the other species of this genus of Hepaticae. In the course of this study a considerable amount of material has been available and it has thus been possible to figure and describe all of the known species of *Sphaerocarpos*. The previous literature relating to the genus, especially the works of Nees von Esenbeck, Professor D. H. Campbell, Dr. Howe, and Professor Charles Douin, has been freely consulted and drawn upon. It is hoped that the information thus brought together and the conclusions drawn from it may be of some service to future students of the genus. For living material I am indebted to Professor C. Massalongo, of Ferrara, Italy, and to Professor Francis E. Lloyd, of Auburn, Alabama; freshly collected specimens, also, I owe to the kindness of Professor R. S. Cocks, of New Orleans, Louisiana. Through the courtesy of Monsieur Hariot, I was enabled to examine an authentic specimen of *S. stipitatus* from the herbarium of the Muséum d'Histoire Naturelle of Paris, our illustrations of this species being drawn from it. I must acknowledge, also, my obligations to Professor Douin, of Chartres, France, for numerous pockets of the two French species in various stages of development; to Dr. E. Levier, of Florence,

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Italy, for excellent specimens from Sardinia and various Italian stations. One of the last mentioned, from Florence, the home of the illustrious Micheli, the author of the name *Sphaerocarpos* and the first botanist to figure and describe one of the species of this genus, has been drawn upon to furnish illustrations of the generic type species. Mr. William E. Nicholson, of Lewes, Sussex, England, has kindly communicated an English specimen of the best known European species. In addition to those already named, one hundred and nine specimens have been examined in the following herbaria: that of the New York Botanical Garden (including those of L. M. Underwood and William Mitten), that of the Sullivant Moss Society, and that of the writer (including that of M. A. Howe).

Miss Lucy MacIntyre and Miss Julia T. Emerson have obligingly aided in making certain translations.

One of the results of this study is to exclude *S. Sphaerocarpos* (*S. terrestris* and *S. Michelii* of authors) from America, as no American specimen has been seen which seems to conform strictly to the characters of this European and possibly North African species. On the other hand, *Sphaerocarpos texanus* (*S. californicus* of authors) appears to have a very wide distribution, specimens from South America, Europe, and Mediterranean Africa being indistinguishable from those of the southern and western United States.

Stephani* gives the following seven species as belonging to the genus *Sphaerocarpos*: *S. terrestris* (Mich.) Smith, *S. Donnellii* Aust., *S. texanus* Aust., *S. Berteroi* Mont., *S. californicus* Aust., *S. cristatus* Howe, and *S. Jamesii* Aust. The last mentioned, Stephani states, was known to him by name only, a specimen being nowhere preserved, though, he adds, it was collected in Mexico. As no reference to such a species has been found in literature, and as Herr Stephani has been unable to give us any clue as to the place of origin of the name, it has been dropped from the list. *Sphaerocarpos texanus* appears to be indistinguishable from *S. californicus*, and, as *S. texanus* was published two years earlier, that name has been adopted. On somewhat similar grounds, though in this case the two names were based on speci-

* Bull. Herb. Boiss. 7 : 656, 657. 1899.

mens from the same locality, *Sphaerocarpos stipitatus* Bisch. replaces *S. Berterii* Mont. (*S. Berteroi* of Stephani's Species Hepaticarum). To the five species thus remaining from Stephani's list, a sixth, the new species from the state of Washington, alluded to at the outset of this paper, is added below.

It should be remarked, perhaps, that *Sphaerocarpos Notarisii*, Mont.* was, a few years after its publication, referred by Montagne to its proper genus *Riella*.

The species of *Sphaerocarpos* are certainly among the simplest and most interesting of the Hepaticae and the importance of the genus from the evolutionary and phylogenetic point of view is clearly set forth in the following quotation from Professor Campbell :†

"From a review of the preceding account of the Liverworts, it will be apparent that these plants, especially the thallose forms, constitute a very ill-defined group of organisms, one set of forms merging into another by almost insensible gradations, and this is not only true among themselves, but applies also to some extent to their connection with the Mosses and Pteridophytes. The fact that the degree of development of gametophyte and sporophyte does not always correspond makes it very difficult to determine which forms are to be regarded as the most primitive. Thus, while *Riccia* is unquestionably the simplest as regards the sporophyte, the gametophyte is very much more specialized than that of *Aneura* or *Sphaerocarpus*. The latter is, perhaps, on the whole the simplest form we know, and we can easily see how from similar forms all of the other groups may have developed. The frequent recurrence of the two sided apical cell, either as a temporary or permanent condition in so many forms, makes it probable that the primitive form had this type of apical cell. From this hypothetical form, in which the thallus was either a single layer of cells or with an imperfect mid-rib like *Sphaerocarpus*, three lines of development may be assumed to have arisen. In one of these the differentiation was mainly in the tissues of the gametophyte, and the sporophyte remained comparatively simple, although showing an advance in the more specialized forms. The evolution of this type is illustrated in the germinating spores of the Marchantiaceae, where there is a transition from the simple thallus with its single apical cell and smooth rhizoid to the complex thallus of the mature gametophyte. In its earlier phases it resembles closely the condition which is permanent in the simpler anacrogynous Jungermanniaceae, and it seems more probable that forms like these are primitive than that they have been derived by a reduction of the tissues from the more specialized thallus of the Marchantiaceae. *Sphaerocarpus*, showing as it does points of affinity with both the lower Marchantiales and the anacrogynous Jungermanniales, probably represents more nearly than any other known form this hypothetical type. Its sporogonium, however, simple as it is, is more perfect than that of *Riccia*, and if our hypothesis is correct, the Marchantiales must have been derived from *Sphaerocarpus*-like forms in which the sporophyte was still simpler than that of existing species. Assuming that this is correct, the further evolution of the Marchantiales is simple enough, and the series of forms from the lowest to the highest very complete."

"In the second series, the Jungermanniales, starting with *Sphaerocarpus*, the line leads through *Aneura*, *Pellia*, and similar simple thallose forms, to several types with more or less perfect leaves — e. g., *Blasta*, *Fossombronia*, *Treubia*, *Ilaplomitrium*. These do not constitute a single series, but have evidently developed independently, and it is quite probable that the typical foliose Jungermanniaceae are not all to be traced

* In De Not. Mem. R. Accad. Torino II. 1 : 343. f. d. 1-8. 1839.

† Campbell, D. H. The structure and development of mosses and ferns 157-159. 1905. [ed. 2.]

back to common ancestors, but have originated at different points from several anacrogynous prototypes."

"The systematic position of the Anthocerotes is more difficult to determine, and their connection with any existing forms known must be remote. While the structure of the thallus and sporogonium in *Notothylas* shows a not very remote resemblance to the corresponding structures in *Sphaerocarpus*, it must be remembered that the peculiar chloroplasts of the Anthocerotes, as well as the development of the sexual organs, are peculiar to the group, and quite different from other Liverworts. To find chloroplasts of similar character, one must go to the green Algae, where in many Confervaceae very similar ones occur. It is quite conceivable that the peculiarities of the sexual organs may be explained by supposing that those of such a form as *Sphaerocarpus*, for example, should become coherent with the surrounding envelope at a very early stage, and remain so until maturity. In *Aneura* we have seen that the base of the archegonium is confluent with the thallus, in which respect it offers an approach to the condition found in the Anthocerotes; but that this is anything more than an analogy is improbable. The origin of the endogenous antheridium must at present remain conjectural, but that it is secondary rather than primary is quite possible, as we know that occasionally the antheridium may originate superficially. In regard to the sporogonium, until further evidence is brought forward to show that *Notothylas* may have the columella absent in the early stages, it must be assumed that its structure in the Anthocerotes is radically different from that of the other Liverworts. Of the lower Hepaticae *Sphaerocarpus* perhaps offers again the nearest analogy to *Notothylas*, but it would not be safe at present to assume any close connection between the two. Of course the very close relationships of the three genera of the Anthocerotes among themselves are obvious."

"On the whole, then, the evidence before us seems to indicate that the simplest of the existing Hepaticae are the lower thallose Jungermanniales, and of these *Sphaerocarpus* is probably the most primitive. The two lines of the Marchantiales and Jungermanniales have diverged from this common ancestral type and developed along different lines. The Anthocerotes cannot certainly be referred to this common stock, and differ much more radically from either of the other two lines than these do from each other, so that at present the group must be looked upon as at best but remotely connected with the other Hepaticae, and both in regard to the thallus and sporophyte has its nearest affinities among certain Pteridophytes. The possibility of separate origin of the Anthocerotes from *Coleochaete*-like ancestors is conceivable, but it seems more probable that they have a common origin, very remote, it is true, with the other Liverworts. They may probably best be relegated to a separate class, coördinate with the Hepaticae and Musci."

Those who follow the Vienna Rules of nomenclature will scarcely be inclined to deny that the first effective post-1753 publication of the genus *Sphaerocarpus* is found in Boehmer's edition of Ludwig's *Definitiones Generum Plantarum*, dated 1760. Strict adherents of the "American Code," however, may discover that *Sphaerocarpus* was not here used in connection with a specific name and that it is not "associable by citation with a *previously published* binomial species." But Ludwig's reference to Micheli, the real founder of the genus, makes the application of the generic name and the type of the genus indisputable. Adanson, who appears to have been the next author to mention the genus, changing the spelling of the final syllable to *us*, meets the American requirements of effective publication no more closely than does Ludwig. The name, in the Michelian sense, appears not to have been used in the binomial form until 1792, though, meanwhile,

the name had been appropriated by Bulliard for a genus of Myxomycetes and by Gmelin for a genus of seed-plants. The Michelian genus, however, was soon generally recognized and its acceptance has been so universal that no synonyms for it are to be found in the literature of the Hepaticae. To attempt at this time to rename on account of a possible slight technical flaw a genus so adequately established by Micheli (even though overlooked by Linnaeus) would seem an act of violence to the spirit, at least, of the priority principle. It may be remarked that *-os* and not *-us* is the ending of the generic name as used both by Ludwig and by its originator Micheli, and that there are the same grounds for adopting it as in the case of *Symphoricarpos*, in which that termination has already become familiar. In fact, the retention of the *-os* ending, it would appear, has been made mandatory by both the Vienna Rules (Art. 57) and the "American Code" (Part III, Section I)

SPHAEROCARPOS (Mich.) Ludwig, Def. Gen. Pl. 501. 1760.—
Mich. Nov. Pl. Gen. 4. *pl.* 3. 1729

Sphaerocarpus Adanson, Fam. Pl. 2: 14. 1763

Gametophores thallus-like, dioicous, annual, small, orbicular to oblong or cuneate, simple or finally once to several times furcate, the broad multistratose midrib passing gradually into the lateral enfolding or inflexed unistratose lobes, intercalary subapical lobes at length nearly equaling the lateral. Cells of gametophore thin-walled, quadrate to long-pentagonal and hexagonal, without trigones. Rhizoids hyaline, smooth, thin-walled, numerous. Sexual organs thickly aggregated along the midrib of dorsal surface of thallus. Antheridial plants minute, scarcely visible to the unaided eye, tinged with purple; antheridia oval, short-stalked, their involucre flask-shaped. Archegonial involucre tubular or clavate to pyriform or subglobose, sessile or long-stipitate. Calyptra ruptured early, a portion with shriveled archegonium-neck long persisting on the apex of capsule. Sporogonium consisting of a globose capsule, an obsolescent stalk, and a bulbous foot,* the last often remaining in the thallus after the detachment of the capsule. Capsule indehiscent, its wall

*The brood-bodies or gemmae mentioned by various authors, among whom Bischoff gave the best description with figure, this latter being copied by Pearson, are probably to be identified with the bulbous detached basal parts of the sporogonia, which in some species remains in thallus. The "grünlichen drüsenartigen Körper" mentioned and figured by Sprengel (Anleit. Kennt. Gewächse 318. f. 78. 1804) are perhaps the oil-bodies which occur here and there in the thallus of *Sphaerocarpus*.

consisting of a single layer of cells destitute of spiral, annular, or other local thickenings. Spores permanently united in tetrads with two exceptions, *S. Donnellii*, in which they become free at full maturity and *S. cristatus*, in which they separate early in the development of the sporogonium; spore-tetrads, when persistent, distinctly areolate, appearing crenulate, papillate or subechinulate in optical section; spores, when separate, compressed-tetrahedral, rounded-lenticular, or sometimes concavo-convex, areolate or cristate, in *S. Donnellii* prominently tuberculate in the basilar circumference. Accompanying the spore mother-cells are smaller starch-bearing sterile cells probably equivalent to elaters morphologically, but lacking a spiral band, these more or less shriveled and obscure at the maturity of the spores.

Type species, *Sphaerocarpos Sphaerocarpos* (Dicks.) M. A. Howe.

Key to the species of *Sphaerocarpos*

♀ involucre sessile or subsessile.

Spores permanently united in tetrads.

♀ involucre contracted at the apex, the diameter of its orifice much less than that of the involucre; spore-tetrad regularly areolate.

♀ involucre pyriform, obovoid, or subglobose; meshes of spore-tetrad 7–15 μ in diameter, the separating ridges low except at their intersections where they are raised into very acute or acicular spicules.

1. *S. Sphaerocarpos*.

♀ involucre tubular, fusiform-clavate, or rarely subpyriform; meshes of spore-tetrad 15–30 μ in diameter, the separating ridges usually high, sinuous, crenulate, or dissected, or sometimes raised to blunt spines at their intersections.

2. *S. texanus*.

♀ involucre wide-mouthed, the diameter of its orifice equaling or often exceeding that of the subjacent part of the involucre.

3. *S. hians*.

Spores separating at maturity, 85–138 μ in maximum diameter, areolate, each while united in the tetrad commonly showing a prominent protuberance about 12 μ high in middle of outer face, and after separation exhibiting a coarsely lobed basilar margin.

4. *S. Donnellii*.

Spores separating long before maturity, 52–80 μ in maximum diameter, typically cristate, less commonly irregularly and sparingly areolate.

5. *S. cristatus*

♀ involucre distinctly stipitate.

6. *S. stipitatus*.

1. SPHAEROCARPOS SPHAEROCARPOS (Dicks.) M. A. Howe, Mem. Torrey Club 7: 66. 1899. [With the *-us* ending.]

Targionia Sphaerocarpos Dicks. Pl. Crypt. 1: 8. 1785. — D.C. Fl. Fr. 2: 419. 1815. — Poll. Fl. Veron. 3: 399. 1824.

- Sphaerocarpus terrestris, minima* Mich. Nov. Pl. Gen. 4. *pl.* 3. 1729. — Dill. Hist. Musc. 536. *pl.* 78. *f.* 17. 1741.
- Sphaerocarpus Michelii* Bell. App. ad Fl. Pedem. 52. 1792 (*fide auctorum*); Mém. Acad. Roy. Sci. Turin 5: 258. 1793; Usteri Ann. Bot. 15: 87. 1795.
- Sphaerocarpus terrestris* J. E. Smith, Eng. Bot. *pl.* 299. 1796. — Bisch. *p. p.* Nova Acta Acad. Leop.-Car. Nat. Cur. 13: 829-838. *pl.* 44. 1827. — Lindenb. *p. p.* Nova Acta Acad. Leop.-Car. Nat. Cur. 18: 496. *pl.* 36. 1836. — Nees, *p. p.* Naturgesch. Europ. Leberm. 4: 365. 1838. — Stephani, *p. p.* Bull. Herb. Boiss. 7: 656. 1899. — Pears. *p. p.* Hep. Brit. Is. 482. *pl.* 215. *f.* 1-14. 1902. — K. Müller, in Rabenh. Krypt.-Fl. Deutschl. Oesterr. & Schweiz 6: 316. *f.* 190, 191. 1907. — C. Douin, Rev. Bryol. 30: 44-57. *f.* 8-21. 1903; 34: 105-112. *f.* 1-3, 11, 15. 1907; 36: 37-41. *f.* 1-3, 5, 6, 8. 1909.
- Sphaerocarpus lagenarius* Dumort. Comm. Bot. 78. 1822.
- Sphaerocarpus utriculosus* Dumort. *loc. cit.*
- Sphaerocarpus terrestris, β? utriculosus* Dumort. Hep. Eur. 164. 1874.

Archegonial thallus orbicular to obovate, 0.6-1.3 mm. in diameter, densely cespitose, bright green when living, yellowish brown when dried, forking several times, lobes short, orbicular, margin ascending or incurved, marginal cells generally quadrate, 33-66 μ ; archegonial involucre 1.5-2.5 mm. high, sessile, thickly crowded together so as almost entirely to conceal the thallus, pyriform, obovoid, or subglobose, orifice small, cells at orifice creniform, quadrate or oblong, 66-85 $\mu \times$ 39-59 μ ; antheridial thallus cuneate to orbicular, 1 mm. in diameter, the rounded lobes curving over the involucre, these 260-330 μ in height, purplish: capsule averaging 750 μ in diameter, the bulbous foot remaining in thallus on detachment of capsule; spores permanently united in tetrads, these 90-120 μ in diameter, greenish or brownish black, finely and regularly areolate, meshes small, 7-15 μ in diameter, each, occasionally, with a single median papilla, ridges low excepting at points of intersection, where they are raised into very acute or acicular spicules, these 7-12 μ in height. [PLATE 25.]

HABITAT: Damp sandy clay; "in clover fields" (England).

TYPE LOCALITY: Florence, Italy.

DISTRIBUTION: Italy, France, Germany, England, and Pantelleria Island (between Sicily and Tunis).

SPECIMENS EXAMINED : Five specimens from Italy, sent by Dr. E. Levier ; living specimens from Ferrara, Italy, sent by Professor C. Massalongo ; eight specimens from France, sent by Professor C. Douin ; a specimen from Baden (between Grötzingen and Weingarten), collected by A. Kneucker ; and a specimen from England, collected by W. H. Burrill, and communicated by Mr. William E. Nicholson.

Adherents of the Vienna Rules will use the name *Sphaerocarpus Michellii* for this species, while for those who follow the "American Code," its legal name is clearly that adopted above.

The areolae of the spore-tetrads of this species occasionally show an isolated median papilla or tubercle (see PLATE 25, FIGURE 12). This peculiarity is so pronounced and constant in certain collections that the possibility of its proving a diagnostic character of an unrecognized species at first suggested itself, but it soon became apparent that this character is sometimes only slightly developed (PLATE 25, FIGURE 10) and also that *S. texanus* shows a parallel series of forms (PLATE 27, FIGURES 11 and 15). It may be mentioned, however, that the spicules of some of these peculiar spore-tetrads with unipapillate areolae are less sharply pointed than is normal in *S. Sphaerocarpus*, approaching the blunt spines of certain forms (PLATE 27, FIGURES 19 and 21) which we are inclined to refer to *S. texanus*.

2. SPHAEROCARPOS TEXANUS Aust. Bull. Torrey Club 6 : 158.

1877. — Underw. Bull. Illinois State Lab. Nat.

Hist. 2 : 30. 1884. — Stephani, Bull. Herb.

Boiss. 7 : 656. 1899.

Sphaerocarpus terrestris Bisch. *p. p.* Nova Acta Acad. Leop.-Car. Nat. Cur. 13 : 829-838. *pl.* 44. 1827. — Lindenb. *p. p.* Nova Acta Acad. Leop.-Car. Nat. Cur. 18 : 496. *pl.* 36. 1836. — Nees, *p. p.* Naturgesch. Europ. Leberm. 4 : 365. 1838. — Pears. *p. p.* Hep. Brit. Is. 482. *pl.* 215. *f.* 1-14. 1902. — Stephani, *p. p.* Bull. Herb. Bois. 7 : 656. 1899.

Sphaerocarpus Berterii Aust. Hep. Bor.-Am. : Tickets of the specimens 34. 1873. Not *S. Berterii* Bisch.

Sphaerocarpus californicus Aust. Bull. Torrey Club 6 : 305. 1879. — M. A. Howe, Mem. Torrey Club 7 : 65. *pl.* 100. *f.* 9-12.

1899. — Stephani, Bull. Herb. Boiss. **7**: 657. 1899. — K. Müller, in Rabenh. Krypt.-Fl. Deutschl. Oesterr. & Schweiz **6**: 317. f. 192. 1907. — Douin, Rev. Bryol. **34**: 105-112. f. 4-10, 12, 13, 14. 1907; **36**: 37-41. f. 4, 7, 10. 1909.

Sphaerocarpus Michellii Underw. p. p. Bull. Illinois State Lab. Nat. Hist. **2**: 30. 1884.

Sphaerocarpus Michellii californicus (Aust.) Underw. l. c.

Archegonial thallus suborbicular or somewhat cuneate, 3-5 mm. \times 4-8 mm., densely cespitose, bright green when living, dingy green or sometimes light olive-green when dried, forking several times, the leaf-like unistratose lobes almost entirely concealed by the overcrowding of the involucre, marginal cells generally quadrate, averaging $45\ \mu$; archegonial involucre 1.2-2.6 mm. high, sessile, long-cylindrical, fusiform-clavate, very rarely subpyriform, more or less acuminate, cells at small orifice usually creniform, $45-60\ \mu$; antheridial thallus oblong to orbicular, 2 mm. in diameter, forking several times, the lobes more conspicuous than those of the archegonial plant; antheridial involucre 270-360 μ high, purplish: capsule averaging 675 μ in diameter, the bulbous foot remaining in thallus on detachment of capsule; spores permanently united in tetrads, these 72-171 μ in diameter, golden-brown to dark opaque-brown, regularly areolate, minutely granulate, meshes 13-30 μ in diameter, each, in rare cases, with a single median papilla or tubercle, the ridges finally high, sinuous, crenulate, or deeply and irregularly dissected, occasionally forming obtuse spines at the points of intersection. [PLATES 26 and 27.]

HABITAT: On flat compact commonly lightly shaded soil in meadows and orchards and beside paths.

TYPE LOCALITY: San Marco, Texas.

DISTRIBUTION: United States, Uruguay, England, France, Germany, Sardinia, and Northern Africa (Tangier).

EXSICC: Hep. Bor.-Am. no. 138, as *S. Berterii* (in herb. New York Botanical Garden). — Hep. Brit. no. 215, as *S. terrestris* (in herb. Underwood). — Hep. Europ. no. 21, as *S. terrestris* (in herb. Underwood).

An examination of mature specimens of *Sphaerocarpus* from various parts of the United States leads to the conclusion that the plant described by Austin as *S. texanus* in 1877 cannot be satisfactorily distinguished from the plant that he described as *S. californicus* two years later. The latter name is therefore considered a synonym of the former. Austin himself seems at first to have

considered them the same, for in his Hep. Bor.-Am. (Tickets of the specimens, 34. 1873) he cites under "138. *Sphaerocarpus Berteri*" the following stations: "California, Bolander, Bigelow; Texas, Wright." Later he recognized his error in identifying these plants with the very different South American species and described the Texan specimens as *S. texanus* Aust. and the Californian as *S. californicus* Aust. Herr Stephani remarks (Bull. Herb. Boiss. 7: 656. 1899) that he had not seen *S. texanus*, that it is not preserved in Austin's herbarium in Manchester, that the plant seems to be wholly lost, but that the very small spores ("coccus $63\ \mu$ ") will make possible its recognition. It has been my good fortune to examine three specimens of *S. texanus* collected by Wright in Texas and now preserved in the herbaria of the New York Botanical Garden and of Columbia University. Two of these came from the Underwood herbarium, one of them being labeled "*Sphaerocarpus texanus* Aust. (type?), San Marco, Tex., C. Wright, 1849, ex coll. W. H. Pearson 1894," and the other "*Sphaerocarpus texanus*, San Marco, Texas, C. Wright, 1849, ex Sulliv." The third is in the herbarium of Columbia University, is labeled "*Sphaerocarpus texanus* Aust. Texas, leg. Wright, ex herb. Aust.," and was communicated by W. H. Pearson in 1890. Austin, in connection with the original description of *S. texanus*, compares it with "*S. Michellii*," stating the *S. texanus* is distinguished by its smaller frond, its involucre less obtuse at the apex, and the spores almost a half smaller. The coccus is described as about $1/400$ of an inch ($62.5\ \mu$) in diameter, while that of *S. Michellii* is $1/200$ – $1/250$ of an inch in diameter. The present writer finds the chief differences separating *S. texanus* from *S. Sphaerocarpos* (*S. Michellii*) to lie in the more pointed fusiform-clavate rather than obovoid involucre, in the meshes of the surface of the spore-tetrads being nearly twice as wide, and in the high ridges forming these meshes being sinuous or crenulate-margined or irregularly dissected, or occasionally rising into obtuse spines at the points of intersection, but never forming sharp needle-like spines as in *S. Sphaerocarpos*. I have not been able to find in the Texan material collected by Wright any spore-tetrads as small as those described by Austin, the smallest seen measuring $72\ \mu$. There is, however, a surprising variation in the size of the tetrads

even on a single plant: those in one capsule measured 72–99 μ , while those in another capsule on the same plant measured 92–132 μ ; these two sets of spore-tetrads were about equally brown, but the smaller had smaller meshes and lower ridges and it is probable that the plant was killed before these smaller ones had reached full maturity.

As indicated above, *Sphaerocarpos texanus* seems to have a wider distribution than any other species of the genus.

It is of interest to note that the classical descriptions of *S. terrestris* given by Bischoff,* by Lindenberg,† and by Nees‡ were based, in large part at least, on specimens collected at various times in vineyards near Durlach, Karlsruhe, Baden, by A. Braun. Now it proves that copious specimens collected by A. Braun in this locality in 1834 (the 1834 collection is mentioned by Nees) and preserved in the Mitten Herbarium are clearly *S. texanus* Aust. (see PLATE 27, FIGURE 17), and it may be said that some of the figures published by Bischoff and by Lindenberg point to *S. texanus* rather than to *S. Sphaerocarpos*. It is to be added, however, that the genuine *S. Sphaerocarpos* (*S. terrestris*)—beautifully distinct—also occurs in Baden and near Karlsruhe, as is attested by specimens collected by A. Kneucker on April 21st, 1894, in vineyards between Grötzingen and Weingarten (see PLATE 25, FIGURE 8), and it is possible that both species were represented in the material obtained by Professor Braun.

3. *Sphaerocarpos hians* sp. nov.

Archegonial thallus oblong or orbicular, 4–6 mm. in diameter, growing in isolated groups, bright green when dried, margin lobed and crispate, ascending, marginal cells generally quadrate, averaging 47 μ ; archegonial involucre 1–2 mm. high, sessile, not crowded together or entirely concealing the thallus, tubular-ovoid, sometimes slightly larger at apex and slightly flaring, orifice large, of the diameter of the involucre or larger, irregular and entire, cells at orifice $26 \times 39 \mu$, with thick walls: antheridial thallus cuneate to orbicular, 2 mm. in diameter, forking several times, the leaf-like lobes curved over the involucre, these 243–398 μ in height, green becoming brown and purplish with age, their cells,

*Nova Acta Acad. Leop.-Car. Nat. Cur. 13: 829–838. pl. 44. 1827.

†Loc. cit. 18: 496. pl. 36. 1836.

‡Naturgesch. Europ. Leberm. 4: 365–369. 1838.

especially those of the neck, thin-walled and nonprotuberant: capsule averaging $587\ \mu$, the bulbous foot remaining attached to capsule; spores permanently united in tetrads, these $66\text{--}83\ \mu$ in diameter, golden-brown, cristate-reticulate, the crests sinuous, $5\ \mu$ high, delicate, somewhat elevated at the angles, occasionally crossing the boundaries of the spores, anastomosing irregularly, forming closed or partially closed meshes or occasionally running in parallel lines toward the boundaries of the spore, a blunt spine occurring now and then within the areolae, the margin in optical section appearing crenulate to tuberculate. [PLATE 28.]

HABITAT: Clayey places in copses; on bare alluvial soil in the shade of willows.

TYPE LOCALITY: Pullman, Washington.

DISTRIBUTION: Washington.

SPECIMENS EXAMINED: *C. V. Piper* 91, type, July 2, 1894, and July 21, 1894, both collected at Pullman, Washington, and preserved in the herbarium of the New York Botanical Garden.

This species resembles most closely *Sphaerocarpos cristatus*, differing markedly in the involucre being tubular with a wide or flaring orifice, instead of being subglobose with small orifice, and in the tetrads remaining permanently united, while in *S. cristatus* they separate long before maturity. The spore markings of the two species are somewhat similar, though those of *S. hians* show more regular reticulations.

4. SPHAEROCARPOS DONNELLII Aust. Bull. Torrey Club 6: 157. 1877. — Underw. Bull. Illinois State Lab. Nat. Hist. 2: 30. 1884. — Stephani, Bull. Herb. Boiss. 7: 656. 1899.

Archegonial thallus cuneate, averaging 9 mm. long and 6 mm. in greatest width, forming mats, dark green, faded green when dried, forking repeatedly, lobes large, explanate, margin sinuous, marginal cells generally oblong, $33 \times 66\ \mu$; archegonial involucre 2–2.3 mm. high, sessile, not crowded together, somewhat isolated, ovoid-ellipsoid, tubular, truncate at apex, orifice somewhat conspicuous, cells at orifice $39\text{--}46\ \mu$: antheridial thallus cuneate, 3 mm. in maximum diameter, each of its five or six main divisions once or twice furcate, lobes large, leaf-like; antheridial involucre 448–996 μ in height, 3 times their diameter, red-brown, cells with somewhat thick walls: capsule averaging $724\ \mu$ in diameter, the bulbous foot remaining in thallus on detachment of capsule; spores separating at maturity; spore-tetrad averaging $145\ \mu$ in diameter just before separating, provided with a promi-

nence $12\ \mu$ in height near the middle of the outer face of each spore, this becoming shriveled at maturity ; spores $85\text{--}138\ \mu$ in maximum diameter, yellow to opaque brown and regularly areolate, coarsely granulate, meshes large, $13\text{--}26\ \mu$, the ridges wrinkled and sinuous, forming elevations at points of intersections of meshes, the spores after separation showing a conspicuous coarsely lobed basilar margin. [PLATES 29 and 30.]

HABITAT : Growing on damp sandy soil, in gardens, etc.

TYPE LOCALITY : Jacksonville, Florida.

DISTRIBUTION : Florida and Georgia.

EXSICC : Hep. Amer. no. 61 (as *Sphaerocarpus terrestris* Mich.) and no. 62 (as *Sphaerocarpus Donnellii* Aust.).

5. SPHAEROCARPOS CRISTATUS M. A. Howe, Mem. Torrey

Club 7: 66. pl. 100. f. 1-8. 1899. — Stephani,

Bull. Herb. Boiss. 7: 657. 1899

Archegonial thallus suborbicular, 3-8 mm. in diameter, pale green when dried, marginal lobes orbicular, ascending, marginal cells generally quadrate, $26\text{--}45\ \mu$; archegonial involucre $0.85\text{--}1.2$ mm. high, sessile, thickly aggregated, at first cylindrical, soon becoming subglobose or obovoid, rounded at apex, orifice small, cells at orifice creniform, $26\text{--}40\ \mu$; antheridial thallus cuneate, 2 mm. in diameter, often once furcate, with oblong-ovate lobes ; antheridial involucre $498\text{--}581\ \mu$ in height, about 2.5 times their diameter : capsule $500\text{--}800\ \mu$ in diameter, the bulbous foot remaining attached to capsule ; spores separating long before the maturity of the capsule, never persisting in tetrads, compressed, rounded-biconvex or sometimes concavo-convex, yellowish brown or pale yellow, $52\text{--}80\ \mu$ in maximum diameter, cristate, the crests sinuous, $4\text{--}7\ \mu$ high, subcrenulate, mostly radiating from near the middle of each of the two faces, often 1-3 times furcate, sparingly anastomosing, forming sometimes 1-6 (rarely more) completely closed meshes in most cases near the middle of the face. [PLATE 31.]

HABITAT : On flat compact soil in meadows and beside paths.

TYPE LOCALITY : Near Stanford University, Santa Clara County, California.

DISTRIBUTION : California.

EXSICC. : Hep. Am. no. 160 (as *S. terrestris*, var. *californicus* Aust.) [*S. texanus*], a little of which is intermingled in some of the sets in the herbarium of the New York Botanical Garden).

This remarkable species is allied to *Sphaerocarpus hians* from Washington, from which it differs in having spores that separate

early instead of remaining permanently in tetrads, in its subglobose archegonial involucre with a small orifice, instead of being long-tubular with orifice the diameter of the involucre. In both of these species the foot remains attached to the capsule on the detachment of the latter from the thallus; the spore markings are somewhat similar. In *S. Donnellii*, the spores separate at maturity, their markings are areolate instead of typically cristate, and they are characterized by a coarsely lobed basilar margin.

The description and drawings published by Professor Campbell in his "Notes on *Sphaerocarpus*" (*Erythea* 4: 73-77. 1896) probably relate chiefly to this species.

6. SPHAEROCARPOS STIPITATUS Bisch.; Lindenb. Nova Acta Acad. Leop.-Car. Nat. Cur. 18: 504 i. *pl.* 36. 1836

Sphaerocarpus Berterii Mont. Ann. Sci. Nat. II. 9: 39. Ja 1838.

— Nees, Naturgesch. Eur. Leberm. 4: 369. 1838. — Mont.

& Nees, in d'Orbigny, Voy. Am. Mérid. 7²: 50. 1839. —

G. L. & N. Syn. Hep. 595. 1846. — Mont. Syll. Gen. Sp.

Crypt. 95. 1846.

Sphaerocarpus Berteroi Stephani, Bull. Herb. Boiss. 7: 657. 1899.

Archegonial thallus suborbicular to oblong, 2 mm. in diameter, in thick cushion-like tufts, light green when dried, margin divided into 4-8 cuneate, ascending, somewhat undulating lobes, marginal cells generally quadrate, averaging 26-39 μ ; archegonial involucre 1.5-2 mm. high, distinctly stipitate (the slender stipes 0.5-0.65 mm. long), tubular-ovoid, ellipsoidal, or bluntly conical, more or less narrowed to the truncate apex, fleshy, carnose-opaque, its wall apparently more than one cell thick, orifice large, of nearly the diameter of the involucre, setulose, the hyaline, thick-walled setulae mostly 2 cells long, incurved: antheridial thallus not seen: capsule 340-420 μ in diameter; the persistent spore-tetrads yellowish, coarsely areolate and somewhat roughened, marginate. [PLATE 32.]

HABITAT: Growing in moist places, on the border of ditches.

TYPE LOCALITY: Quillota, Chile.

SPECIMEN EXAMINED: B. Bertero, 695, August and September 1829, in the herbarium of the Muséum d'Histoire Naturelle of Paris, France.

The description of the capsule and spores has been derived from literature mentioned above.

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Explanation of plates**PLATE 25. *Sphaerocarpos Sphaerocarpos***

1. ♀ plant, mature, $\times 14$. 2. ♀ plant, immature, $\times 14$. 3 and 4. ♂ plants, $\times 29$. 5. Orifice of ♀ involucre, $\times 48$. 6, 8, 10, and 12. Spore-tetrads, $\times 390$. 7, 9, 11, 13. Spicules and ridges of spore-tetrads shown in optical section, $\times 390$; 7 was drawn from spore shown in fig. 6; 9, from that shown in fig. 8; 11, from that shown in fig. 10; 13, from that shown in fig. 12.

Figures 1 and 5 were drawn from a specimen collected by O. Beccari, near Florence, Italy, 9 February, 1898; 2, 3, 4, 6 and 7, from a specimen collected by E. Bacci, near Florence, Italy, 9 March, 1888; 8 and 9, from a specimen collected by A. Kneucker, between Grötzingen and Weingarten, Baden, Germany, 21 April, 1894; 10 and 11, from a specimen collected by W. H. Burrill, Strumpshaw, E. Norfolk, England, April, 1908; 12 and 13, from a specimen collected by A. Mori, at Pisa, Italy, December, 1881 (Erb. Critt. Ital., ser. II, no. 1201).

PLATES 26 and 27. *Sphaerocarpos texanus*

1. ♀ plant, $\times 14$. 2. ♂ plant, $\times 29$. 3. Orifice of ♀ involucre, $\times 48$. 4, 5, 7, 9, 11, 13, 15, 17, 19, and 21. Spore-tetrads, $\times 390$. 6, 8, 10, 12, 14, 16, 18, 20, and 22. Ridges of spore-tetrads shown in optical section, $\times 390$; 6 was drawn from spore shown in fig. 5; 8, from that shown in fig. 7; 10, from that shown in fig. 9; 12, from that shown in fig. 11; 14, from that shown in fig. 13; 16, from that shown in fig. 15; 18, from that shown in fig. 17; 20, from that shown in fig. 19; 22, from that shown in fig. 21.

Figures 1, 2, 4, 9, and 10 were drawn from specimens collected by C. Wright, at San Marco, Texas, 1849; 3, 7, and 8, from specimens collected by M. A. Howe, Mill Valley, California, 4 April, 1896 (in herb. Haynes); 5 and 6, from a specimen collected by J. Arechavaleta, no. 151, at Montevideo, Uruguay, August, 1876 (in herb. Mitten); 11 and 12, from a specimen collected by Welwitsch, no. 28 [Portugal?] (in herb. Mitten); 13 and 14, from a specimen collected in Tangier in the winter of 1826 (in herb. Mitten); 15 and 16, from a specimen collected by H. A. Green, Chester, South Carolina, 4 March, 1886 (in herb. Haynes); 17 and 18, from a specimen collected by A. Braun, Durlach, Baden, March, 1834 (in herb. Mitten); 19 and 20, from a specimen labeled *S. Micheli*, herb. P. V. LeRoy, Florida (in herb. New York Botanical Garden); 21 and 22, from a specimen collected by Gennari in Sardinia, April, 1889.

PLATE 28. *Sphaerocarpos hians*

1. ♀ plant $\times 14$. 2. ♂ plant, $\times 29$. 3. Orifice of ♀ involucre, $\times 48$. 4, 5, and 6. Spore-tetrads, $\times 390$. 7. Ridges of spore-tetrad shown in optical section, $\times 390$.

The figures were all drawn from the type specimen, collected by C. V. Piper, no. 97, Pullman, Washington, 2 July, 1894

PLATES 29 and 30. *Sphaerocarpos Donnellii*

1. ♀ plant, $\times 14$. 2. ♂ plant, $\times 29$. 3. Spore, showing outer face and coarsely lobed basilar margin. 4. Spore, showing tubercular prominence on outer face, in a lateral view, $\times 390$. 5. ♂ plant, showing greatly elongated necks of involucre on old parts of thallus, $\times 48$. 6. Spore-tetrad, nearly mature, $\times 390$. 7. Ridges of spore and tubercular prominence shown in optical section, $\times 390$. 8. Spore-tetrad beginning to separate, $\times 390$. 9. Orifice of ♀ involucre, $\times 48$.

Figure 1 was drawn from a specimen collected by Severin Rapp, in Florida, February, 1905; 5, from Hep. Am. no. 61; 2, 3, 4, 5, 6, 7, 8, and 9, from Hep. Am. no. 62.

PLATE 31. *Sphaerocarpos cristatus*

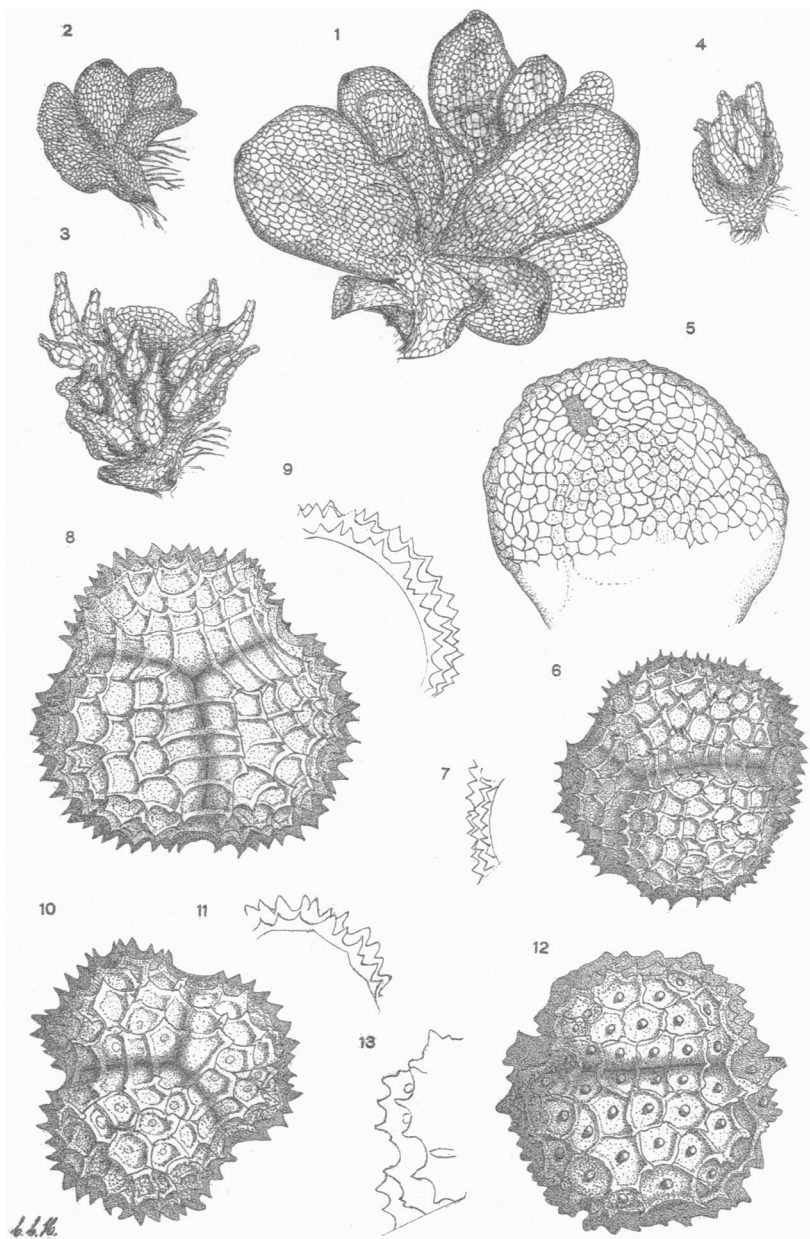
1. ♀ plant, $\times 14$. 2. ♂ plant, $\times 29$. 3. Orifice of ♀ involucre, $\times 48$. 4, 5, 6, and 7. Spores, $\times 390$.

The figures were all drawn from the type material.

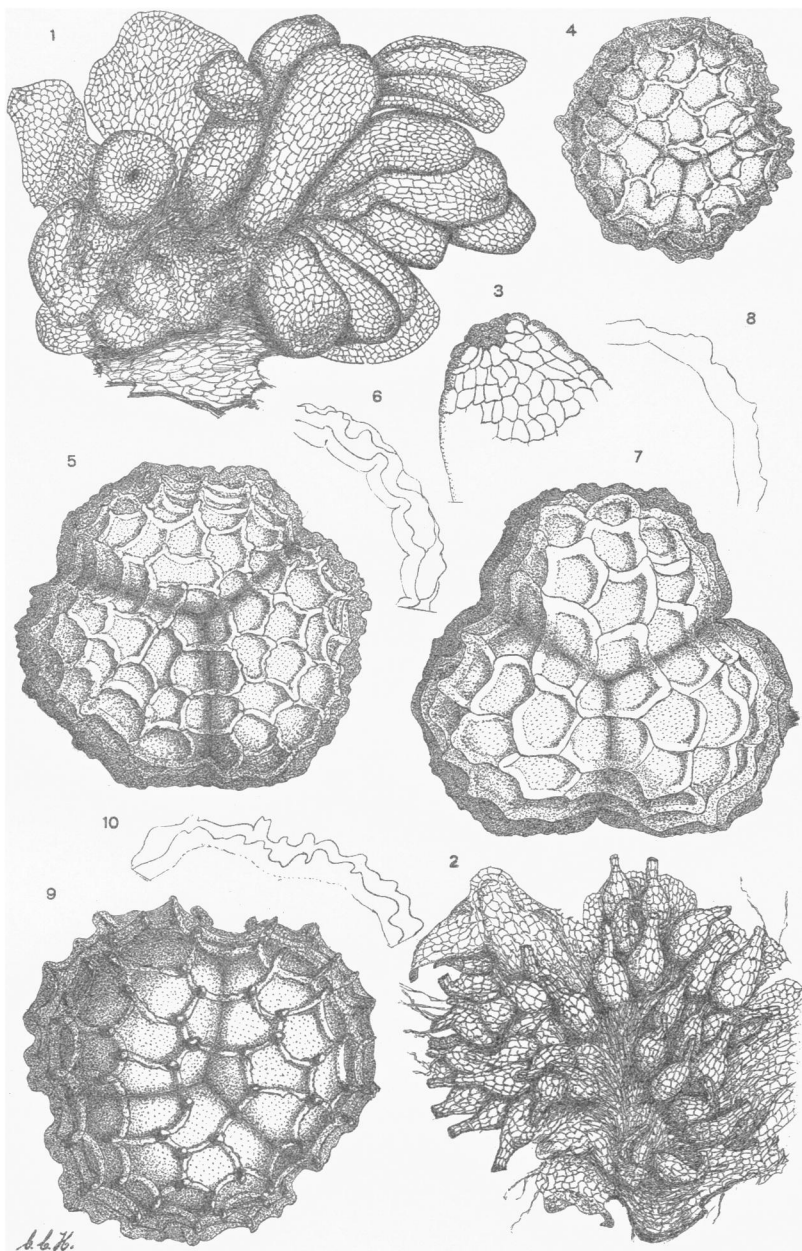
PLATE 32. *Sphaerocarpos stipitatus*

1. ♀ plant, immature, $\times 29$. 2. ♀ involucre, $\times 14$. 3. Orifice of ♀ involucre, showing setulae, $\times 120$. 4 and 5. ♀ plants, $\times 14$ (drawn to scale of other species). 6. Portion of sterile plant, $\times 14$.

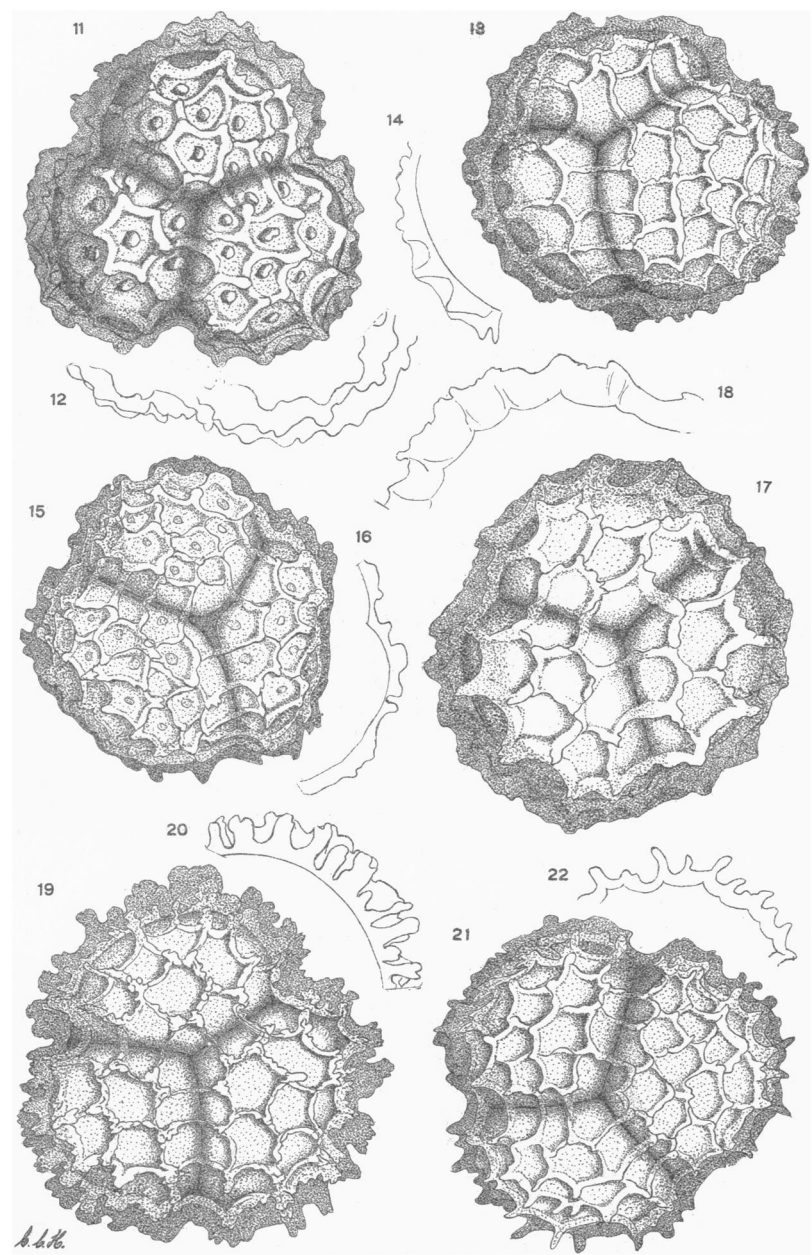
The figures were all drawn from material of the original collection preserved in the Muséum d' Histoire Naturelle of Paris.



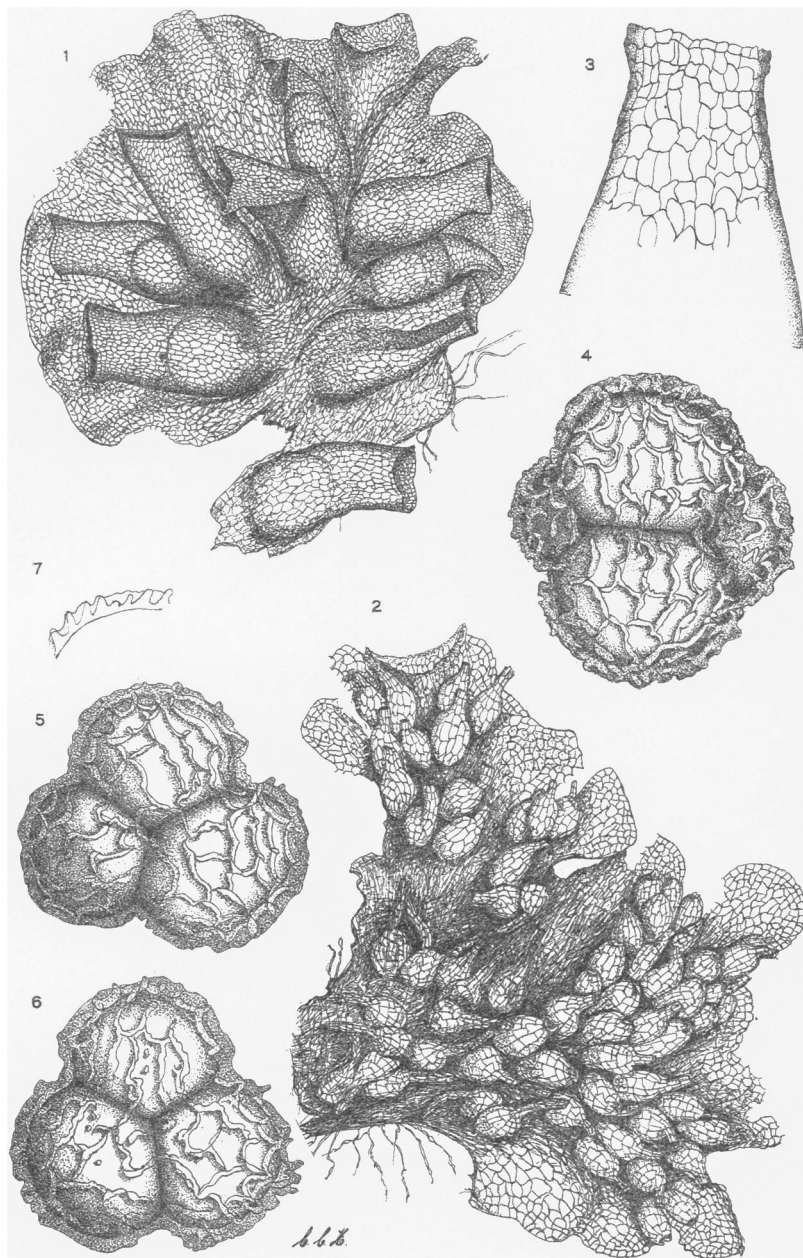
SPHAEROCARPOS SPHAEROCARPOS (Dicks.) M. A. Howe



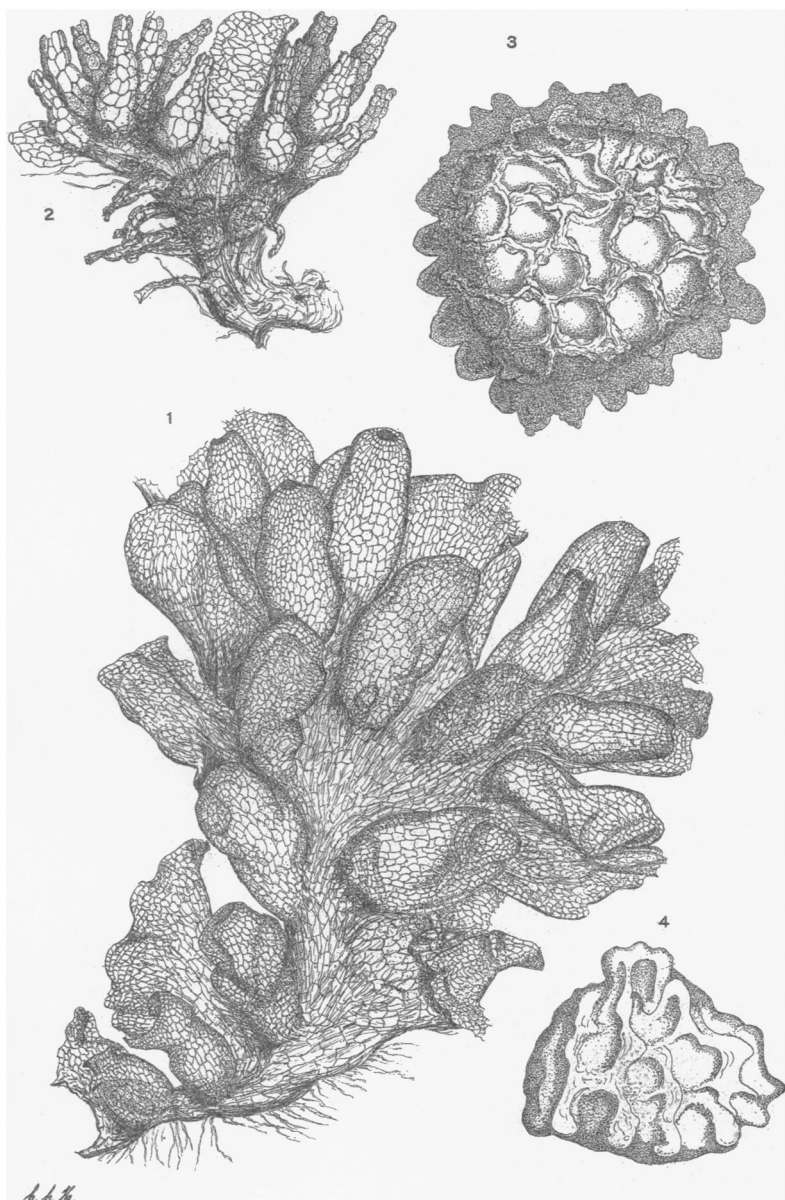
SPHAEROCARPOS TEXANUS Aust.



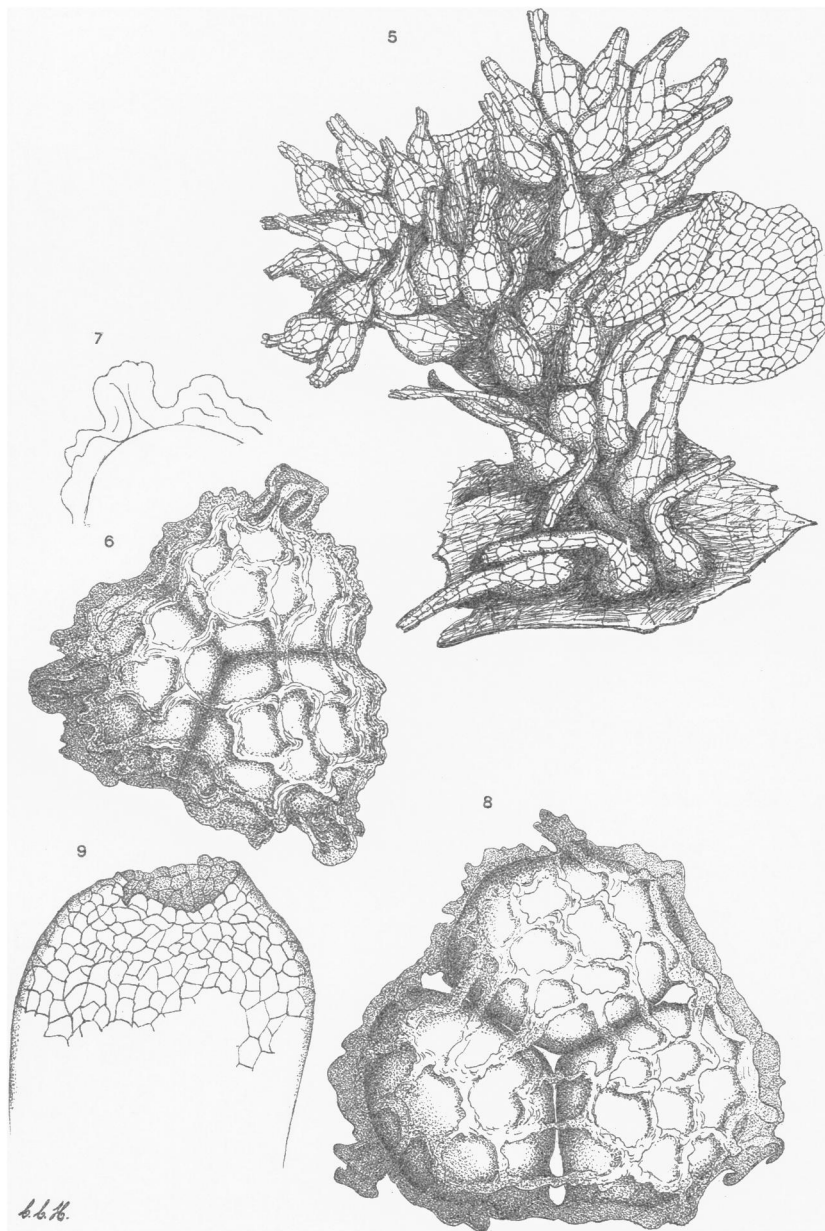
SPHAEROCARPOS TEXANUS Aust.



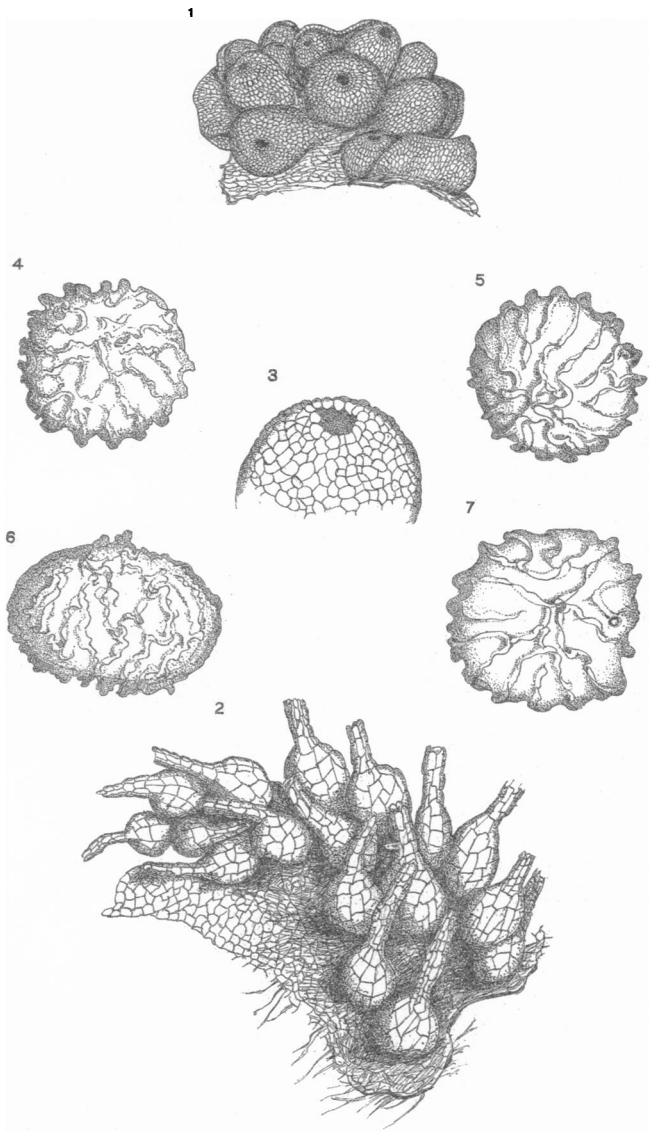
SPHAEROCARPOS HIAN Haynes



SPHAEROCARPOS DONNELLII Aust.

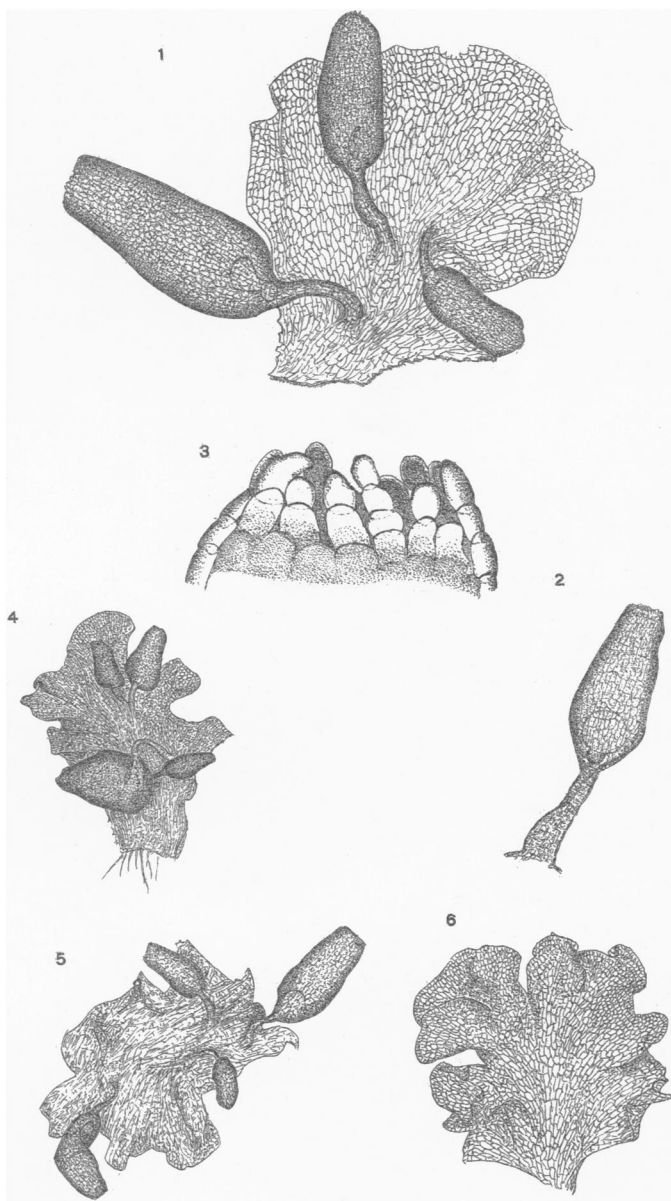


SPHAEROCARPOS DONNELLII Aust.



l.l.v.

SPHAEROCARPOS CRISTATUS M. A. Howe



b. b. H.

SPHAEROCARPOS STIPITATUS Bisch.